UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **October/November 2013**

1 hour 15 minutes

Additional Materials: Answer Booklet/Paper
Graph Paper
List of Formulae (MF9)

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READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

This document consists of **3** printed pages and **1** blank page.

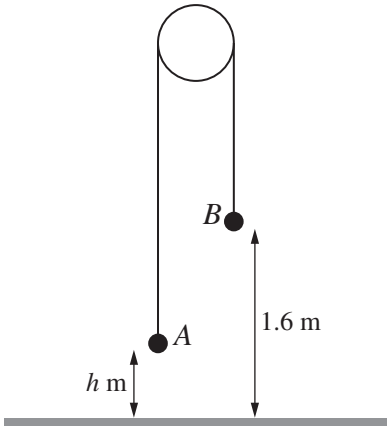
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1 A particle moves up a line of greatest slope of a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = 0.28$. The coefficient of friction between the particle and the plane is $\frac{1}{3}$.

(i) Show that the acceleration of the particle is $-6\,\text{m s}^{-2}$. [3]

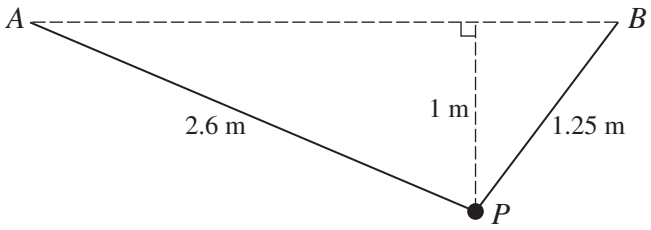
(ii) Given that the particle's initial speed is $5.4\,\text{m s}^{-1}$, find the distance that the particle travels up the plane. [2]

2



Particle A of mass 0.2 kg and particle B of mass 0.6 kg are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley. B is held at rest at a height of 1.6 m above the floor. A hangs freely at a height of h m above the floor. Both straight parts of the string are vertical (see diagram). B is released and both particles start to move. When B reaches the floor it remains at rest, but A continues to move vertically upwards until it reaches a height of 3 m above the floor. Find the speed of B immediately before it hits the floor, and hence find the value of h. [6]

3



A particle P of mass 1.05 kg is attached to one end of each of two light inextensible strings, of lengths 2.6 m and 1.25 m. The other ends of the strings are attached to fixed points A and B, which are at the same horizontal level. P hangs in equilibrium at a point 1 m below the level of A and B (see diagram). Find the tensions in the strings. [6]

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4 A box of mass 30 kg is at rest on a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = 0.1$, acted on by a force of magnitude 40 N. The force acts upwards and parallel to a line of greatest slope of the plane. The box is on the point of slipping up the plane.

(i) Find the coefficient of friction between the box and the plane. [5]

The force of magnitude 40 N is removed.

(ii) Determine, giving a reason, whether or not the box remains in equilibrium. [2]

5 A car travels in a straight line from A to B, a distance of 12 km, taking 552 seconds. The car starts from rest at A and accelerates for T_1 s at $0.3\ \text{m s}^{-2}$, reaching a speed of $V\ \text{m s}^{-1}$. The car then continues to move at $V\ \text{m s}^{-1}$ for T_2 s. It then decelerates for T_3 s at $1\ \text{m s}^{-2}$, coming to rest at B.

(i) Sketch the velocity-time graph for the motion and express T_1 and T_3 in terms of V. [3]

(ii) Express the total distance travelled in terms of V and show that $13V^2 - 3312V + 72\,000 = 0$. Hence find the value of V. [5]

6 A lorry of mass 12 500 kg travels along a road from A to C passing through a point B. The resistance to motion of the lorry is 4800 N for the whole journey from A to C.

(i) The section AB of the road is straight and horizontal. On this section of the road the power of the lorry's engine is constant and equal to 144 kW. The speed of the lorry at A is $16\ \text{m s}^{-1}$ and its acceleration at B is $0.096\ \text{m s}^{-2}$. Find the acceleration of the lorry at A and show that its speed at B is $24\ \text{m s}^{-1}$. [3]

(ii) The section BC of the road has length 500 m, is straight and inclined upwards towards C. On this section of the road the lorry's driving force is constant and equal to 5800 N. The speed of the lorry at C is $16\ \text{m s}^{-1}$. Find the height of C above the level of AB. [5]

7 A vehicle starts from rest at a point O and moves in a straight line. Its speed $v\ \text{m s}^{-1}$ at time t seconds after leaving O is defined as follows.

$$\text{For } 0 \leqslant t \leqslant 60, \quad v = k_1 t - 0.005t^2,$$

$$\text{for } t \geqslant 60, \quad v = \frac{k_2}{\sqrt{t}}.$$

The distance travelled by the vehicle during the first 60 s is 540 m.

(i) Find the value of the constant k_1 and show that $k_2 = 12\sqrt{(60)}$. [5]

(ii) Find an expression in terms of t for the total distance travelled when $t \geqslant 60$. [2]

(iii) Find the speed of the vehicle when it has travelled a total distance of 1260 m. [3]

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